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Glaucoma Treatment Breakthrough

University of Dayton, Ohio (url: http://www.udayton.edu/index.php)

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A "smart" nanomaterial recently developed at the University of Dayton Research Institute for multi-purpose use in aircraft coatings, wind turbines and other large-scale commercial applications may also lead to a significant breakthrough in glaucoma treatment.

Nicknamed "fuzzy fiber" by inventor Khalid Lafdi, distinguished research engineer at the University of Dayton Research Institute, the tailored carbon material is expected to improve the lives of glaucoma sufferers by reducing the number of medical procedures needed to treat the disease.

The new technology will be used to create biocompatible, non-clogging drainage tubes to relieve excess fluid and pressure in the eye. The carbon tubes will be marketed as an alternative to silicone tubes, which must be replaced in most patients because they become encapsulated with naturally occurring growth cells called fibroblasts, inhibiting their ability to drain fluid.

Mobius Therapeutics in St. Louis, owned and operated by University of Dayton graduate Ed Timm, sponsored the research. Mobius supports research and development for advances in treatment for glaucoma.

Glaucoma affects more than four million Americans. It is the second-leading cause of blindness overall and the leading cause of blindness among African-Americans, according to the Glaucoma Research Foundation. It occurs when the eye stops naturally draining fluid, and the resulting increased intraocular pressure, or IOP, damages the optic nerves in the eye.

"Glaucoma is frequently called the 'sneak thief of sight' because damage occurs slowly, and there are no symptoms until vision starts to become lost," Timm said. "Once damage is done, that vision loss cannot be reversed."

Because prevention is the "absolute best treatment," annual eye exams that include a simple test for glaucoma are critical to helping prevent blindness, Timm said.

"If glaucoma is detected, typically the first line of therapy is in the form of pharmaceuticals — drugs that help maintain proper IOP," Timm said. "If drugs are not appropriate or are no longer working, the next line of treatment involves using a laser to create a hole in the eye for fluid drainage. But the body responds by producing fibroblasts, a kind of scar tissue that can close up the hole and cause additional problems."

When surgical intervention is warranted, a silicone shunt is implanted in the eye to facilitate drainage. Silicone is highly biocompatible, which is also its downfall, Timm said.

"Silicone is not just the wrong material to use, it is *exactly* the wrong material," Timm said. "Because the body does not see it as a foreign material, the tube immediately becomes encapsulated with fibroblasts as healing takes place around it. As scar tissue builds up over time, the tube can no longer drain fluid and must be replaced."

Lafdi and Timm designed a drain tube using Lafdi's "fuzzy fiber," a scaffold of carbon — also highly biocompatible — covered with surface-treated carbon nanotubes grown in a highly controlled manner, giving the material its fuzzy appearance. Those chemically modified nanotubes prevent the formation and build-up of fibroblasts, according to Lafdi.

"Multiple tests demonstrated that, in the presence of tailored carbon nanotubes, there was zero cell growth. But when I coated the same carbon scaffold with silicone, there was cell proliferation. An absolute invasion," Lafdi said.

Originally developed with federal and state funding, the fiber is also the critical component in Nano Adaptive Hybrid Fabric (NAHF-X™), a new "smart" material developed by Lafdi and colleagues that allows composites to be tailored for electrical and thermal conductivity, chemical and biological sensing, energy storage and conversion, thermal management and other properties.

"The same composite used as structural material for a wind turbine blade could also detect the presence of ice on the blade in winter, then heat itself up to de-ice the blade," Lafdi said. "We are moving toward multifunctional composites in a true sense."

Timm said use of the material in glaucoma treatment is revolutionary.

"There's nothing else like it out there. Not only is the material completely biocompatible, eliminating the risk for rejection by the body, it will also serve to preserve the longevity of the implant by keeping it from becoming blocked with tissue," Timm said. "I believe this will completely change the thought process in the design of future ophthalmic devices."

Pending successful clinical trials in humans, the tubes should be on the market within three years, according to Timm.

The patent application for the technology covers applications for ear drainage tubes in addition to ophthalmic use, said Lafdi, who is also a faculty member in the University's School of Engineering.

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